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## A COMPARISON OF RECENT AUTHORITIES ON METHODS OF TEACHING BOTANY

IN the work in physics and chemistry in secondary schools, there is pretty general agreement regarding the essentials to be taught and the method of teaching them. Unfortunately, the same cannot be said of botany. As it is actually taught there are found the two extremes of devoting all the time, on the one hand, to a study of types, and on the other, to a study of the flowering plants alone; and between these extremes are found a great variety of gradations and combinations; and among the many text-books of botany now extant, there may be chosen several, representing such extremes of methods as to be exceedingly bewildering to one who is looking to them for suggestions. As a concrete instance of one source of this confusion, reference may be made to the report of the Committee of Ten, made in 1894, and to that of the Committee on College Entrance Requirements, made in 1899, both under the supervision of the National Educational Association. The first report recommends that the entire year be devoted to the study of types. The second report recommends that only half a year be devoted to this kind of work, and that in the other half, the study of ecology and physiology be made prominent. That such differences should appear in these reports, made only five years apart and under the jurisdiction of the same association, is sufficient indication of the radical changes that methods in botany have been undergoing.

But while a comparison of certain reports and text-books seems to present most divergent methods, a more prolonged study of a larger amount of literature indicates a general consensus of opinion in the main features as to what should be taught in an elementary course in botany, and suggests the thought that perhaps now we are approaching a standard that will become general. In justification of this statement, an

attempt is made in the table below to indicate the relative importance assigned to the various departments of botany, as gathered from a number of recent text-books and reports.

The divisions of botany now especially emphasized are physiology, ecology, and morphology. For the sake of present convenience, the last topic may be divided into three sub-topics: the study of types, or general morphology; the detailed study of the angiosperms, or special morphology; and the study of the structure and modifications of the organs of seed-plants, such as the seed, root, stem, leaf, flower, and fruit, or gross morphology. In the table a distinction is made between the several grades of importance given these five topics by the various authors. When stress is laid about equally on all the topics discussed, each is marked "important;" when one topic is especially emphasized above the rest, it is marked "very important;" when any topic receives only slight attention, it is marked "slightly important;" and when a topic receives no consideration, it is marked "not mentioned." That in some cases the purposes of the author may have been misunderstood is very probable, but perhaps the general deductions from all combined may prove not essentially inaccurate.

The reports and text-books referred to below are: (1) Report of Committee of Ten; (2) report of New York State Science Teachers' Association; (3) report of Committee on College Entrance Requirements, of the National Educational Association; (4) provisional report of committee appointed by the Society for Plant Morphology and Physiology to formulate a standard college entrance option in botany; (5) Spalding's *Introduction to Botany*; (6) Macbride's *Lessons in Botany*; (7) Bessey's *Essentials of Botany*; (8) Setchell's *Laboratory Practice for Beginners*; (9) Barnes' *Plant Life*; (10) Coulter's *Plants*; (11) Ganong's *Teaching Botanist*; (12) Atkinson's *Elementary Botany*; (13) Bailey's *Botany*; (14) Lloyd's "Course in Botany in the Horace Mann High School, outlined in *Teachers' College Record*, January, 1901; (15) *Studies of Plant Life*, by Pepoon, Mitchell, and Maxwell; (16) Bergen's *Foundations of Botany*. With the exceptions of Nos. 6 and 14, the plans outlined give work for a year's course.

Abbreviations — Imp., important; S., slightly; V., very; N. M., not mentioned.

Author	Ecology	Physiology	General Morphology	Gross Morphology	Special Morphology
1. Comm. Ten. (1894) . . . . .	N. M.	N. M.	V. Imp.	N. M.	N. M.
2. N. Y. S. S. T. A. (1898) . . . .	Imp.	V. Imp.	Imp.	S. Imp.	Imp.
3. Comm. C. E. R. (1899) . . . .	V. Imp.	Imp.	Imp.	Imp.	S. Imp.
4. Comm. S. P. M. (1901) . . . .	Imp.	Imp.	Imp.	Imp.	N. M.
5. Spalding (1893) . . . . .	Imp.	S. Imp.	Imp.	Imp.	Imp.
6. Macbride (1895) . . . . .	S. Imp.	S. Imp.	S. Imp.	V. Imp.	V. Imp.
7. Bessey (1896) . . . . .	S. Imp.	S. Imp.	V. Imp.	Imp.	S. Imp.
8. Setchell (1896) . . . . .	Imp.	N. M.	N. M.	V. Imp.	N. M.
9. Barnes (1898) . . . . .	Imp.	Imp.	Imp.	Imp.	N. M.
10. Coulter (1899) . . . . .	V. Imp.	Imp.	Imp.	Imp.	N. M.
11. Ganong (1899) . . . . .	Imp.	Imp.	Imp.	Imp.	N. M.
12. Atkinson (1900) . . . . .	Imp.	V. Imp.	Imp.	S. Imp.	Imp.
13. Bailey (1900) . . . . .	V. Imp.	S. Imp.	S. Imp.	Imp.	Imp.
14. Lloyd (1900) . . . . .	Imp.	Imp.	Imp.	Imp.	N. M.
15. Pepoon (1900) . . . . .	Imp.	Imp.	Imp.	Imp.	S. Imp.
16. Bergen (1901) . . . . .	Imp.	Imp.	Imp.	Imp.	S. Imp.
SUMMARY—					
Very important . . . . .	3 } 13	2 } 10	2 } 13	2 } 13	1 } 5
Important . . . . .	10 }	8 }	11 }	11 }	4 }
Slightly important . . . . .	2 } 3	4 } 6	2 } 3	2 } 3	4 } 11
Not mentioned . . . . .	1 }	2 }	1 }	1 }	7 }

In considering the work to be done in a course in botany, it should be kept in mind that there are two distinct problems to solve according to the time to be devoted to the course, whether a whole year or a half year. The difficulties presented by the first problem are not numerous, but a satisfactory solution of the second is much more difficult. The consideration of the former problem will first occupy our attention.

In accordance with the table, there is seen to be a general demand for the recognition of physiology, ecology, general morphology, and gross morphology. The idea that the different subjects should be treated separately is strongly repudiated. Physiology and gross morphology should be taken up together and ecology should accompany all the subjects. The demand for the study of physiology and ecology are protests against the old method of looking on plants as lifeless things to be analyzed, classified, and laid away like minerals. It is insisted that the student shall be taught to look on plants as possessing life just as truly as do animals, and as having life problems to solve.

Some study of the organs of plants is necessary to a clear understanding of physiology and of some features of ecology, and, furthermore, it has other advantages of its own without reference to these subjects. The demand for a study of types is a protest against the one-sided and unscientific method of devoting the entire time to one class only of the whole plant kingdom, as has been done so largely in the study of angiosperms. The first reaction against this idea was itself one-sided in some cases. In the report of the Committee of Ten this was carried to the extreme, but an examination of the above table lends no sanction to the view that the study of types is being abandoned and the return being made to something like the old plan of studying the flowering plants.

It is more difficult to determine the place that shall be assigned to special morphology. The authorities are about equally divided as to whether it should have any place at all in the regular course. But those who would assign no place to this subject, together with those who would assign but a subordinate place to it, form a large majority. Those who favor the study of special morphology suggest two ways in which it may be taken up. There are some who follow a systematic study of families such as is outlined in Spalding's and Atkinson's *Botanies*; while others pursue this line of work by means of analysis of flowers and the determination of species by the use of keys, such as are found in Bergen's and Bailey's *Botanies*. But while Bergen has appended a key to his *Botany*, he says in his *Handbook*:

To the author the analysis of flowering plants seems one of the least important of the many topics for study by a class in elementary botany. Whatever work is done in determination of species should be done with extreme thoroughness and supplemented by some such studies of the families of seed-plants as are outlined in Spalding's *Introduction to Botany*.

The plan still so prevalent in many of our schools of requiring the pupil to prepare a herbarium is almost unanimously condemned, either directly by those who refer to the matter at all, or indirectly by those who provide no place for such work in the plan of study. The objection offered to this kind of work

is not that the training thus gained has no value, but that the time can be more profitably spent in other ways.

A fair conclusion with reference to this subject as upheld by a comparative study of the authorities named in the table, seems to the writer to be that the present tendency is decidedly away from the study of special morphology; but that if this subject is taken up at all, it be by a systematic study of families, leaving the use of keys and the preparation of herbariums as voluntary work for such as are specially interested. But even granting that special morphology should have a place in the course, there is no justification for allowing it to occupy a larger part of the time as is so frequently done in our schools. Those who favor the study of this subject make it but one of several subjects to be included in the course, and thus allow for it a corresponding proportion of time.

As already stated, the plans outlined in the table are intended for a year's course, excepting those of Macbride and Lloyd. But the report of the New York State Science Teachers' Association, that of the Committee on College Entrance Requirements, and that of the committee appointed by the Society for Plant Morphology and Physiology, and Spalding in his *Botany*, present suggestions also for a half year's course; and Barnes, Coulter, Atkinson, and Bergen have prepared text-books for a half year's course; and the writer has ascertained through correspondence the views of Professor Ganong with reference to the shorter course.

There is quite general unanimity of opinion that the first four topics in the table should be included in a year's course, but there is much difference of opinion as to what should be included in a half year's course. There is one school which would treat the same topics in a half year as in a year, only less thoroughly by a selection of the more central parts. Another school would exclude entirely some topics included in the year's course and treat the remaining topics as thoroughly in one case as in the other, thus making the half year's course the same as the first half of the year's course. Of the four topics which have been found to be generally accepted for the year's work, this school would omit entirely general morphology. To the

first school belong Atkinson, Barnes, Bergen, Coulter, Lloyd, Spalding, and the report of the New York State Science Teachers' Association. To the second school belong Ganong, Report of the Committee on College Entrance Requirements, and that of the committee appointed by the Society for Plant Morphology and Physiology.

Thus, judging from mere numbers, the weight of authority seems to be with the first school. But there are several considerations to be taken into account in forming a fair estimate of the relative value of these two schools. The authority of the Committee on College Entrance Requirements is not that of one man, but of a Committee of Twelve appointed by the National Educational Association, and hence is entitled to more weight. The report next referred to in the second school is also that of a committee composed of three members. This report is worthy in all respects of most careful consideration as being the latest publication on this subject, and as being prepared under the jurisdiction of so large and prominent a body as is the Society for Plant Morphology and Physiology. The plan of this society in appointing this committee was that its preliminary report should be submitted to the members, and that the committee should be guided by any opinion submitted by a majority of its members. Professor Ganong writes that the final report has been prepared, but is not ready for distribution, but that it does not differ materially from the preliminary report. The committee appointed by this society consists of Professors Ganong, Lloyd, and Atkinson. The last two of these had previously prepared outlines for a half year's course, following the plan of the first school; but as the report was written later than these outlines, it would seem fair to cancel these two (No. 14 and the abbreviated course of No. 12) in balancing the weight of authority. And, furthermore, this change of plan by these two men is of special interest as indicating the tendency of the present change of opinion.

After the discussion of special morphology in its relation to a year's course, it needs only be added that, in its relation to a half-year's course, some members of the second school who

assign a place of slight importance to this topic in a year's course, do so in connection with the study of types, which, in accordance with their views, should not be included in a half-year's course, so that there is less justification for including this topic in the work of a half year than in that of a year.

Thus, while there is considerable difference of opinion concerning the place that shall be assigned to general and to special morphology in a half-year's course in botany, there is almost unanimous agreement that gross morphology, physiology, and ecology should form the backbone of the course.

While there is quite general agreement, and more especially in a year's course, concerning the subjects to be studied, there is considerable disagreement as regards the methods to be followed and the relative time to be used for each subject. On the one hand is the report of the Committee of Ten, recommending that the study of types occupy all the time, while on the other hand are books, like Setchell's, in which the subject is barely mentioned. But, in spite of these extremes, there are quite a number who would devote approximately one half of the time in a year's course to the study of types, the other half to physiology and gross morphology, ecology being taken up in connection with all the topics. Such is the plan of the Committee on College Entrance Requirements, of that appointed by the Society for Plant Morphology and Physiology, and of Coulter, Ganong, Lloyd, and Pepoon. And this seems to be the tendency, to divide the work into two parts occupying about equal times, one the study of the general principles of botany, or general botany; the other, the study of the chief groups of plants, or special botany. This tendency is seen, not only in text-books proper, but in the larger works suitable for reference, such as *A Text-book of Botany*, by Strasburger, Noll, Schenck, and Schimper.

And again, as regards the order of taking up the study of types, there are two schools. One begins with the lower forms and works up in the logical and evolutionary order. The other begins with the higher and better known forms and works from the known to the unknown. The weight of the above authorities is most decidedly in favor of the first method, there being



only two exceptions, Lloyd and Macbride. With perhaps one exception, there is quite general agreement that the study of types should not be the first topic taken up, as it is not best to introduce the use of the microscope at the very beginning of the course.

The books mentioned in the table differ somewhat in the purpose that they are intended to serve. Three general classes of books may be distinguished. First, there are laboratory guides which furnish no reading at all for the student; then there are text-books which furnish no directions for laboratory work, but only material to be studied by the pupil; and lastly, there are those that serve as both laboratory guide and text-book. While this last class of books has been widely used, in recent years there has been a tendency in many quarters to use separate books for laboratory guide and text-book, or to use books in which these two features are kept separate, thus following the plan quite generally adopted in the teaching of physics and chemistry.

A historical study of the methods of teaching botany shows a sort of inverse ratio of importance now placed on the various topics, as compared with the time that has passed since each was especially emphasized as the central theme. Physiology and ecology are the most recent additions to botany, and the most emphasized. The study of types takes us back to a little earlier stage, and, while still important, is not emphasized to the same extent as the subjects first mentioned. The study of the organs of the flowering plants remains as an important feature to be taken up in connection with physiology, though secondary to it, and this takes us back to a still earlier period when the gross morphology of plants was the central idea of botany. And lastly, and least emphasized, is the special study of the flowering plants by the analysis of flowers and the determination of species, which takes us still farther back to the time when the study of botany consisted almost entirely of this kind of work. Thus, from each of these epochs in the history of botanical teaching, has been taken something of value to make up the present plan.

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